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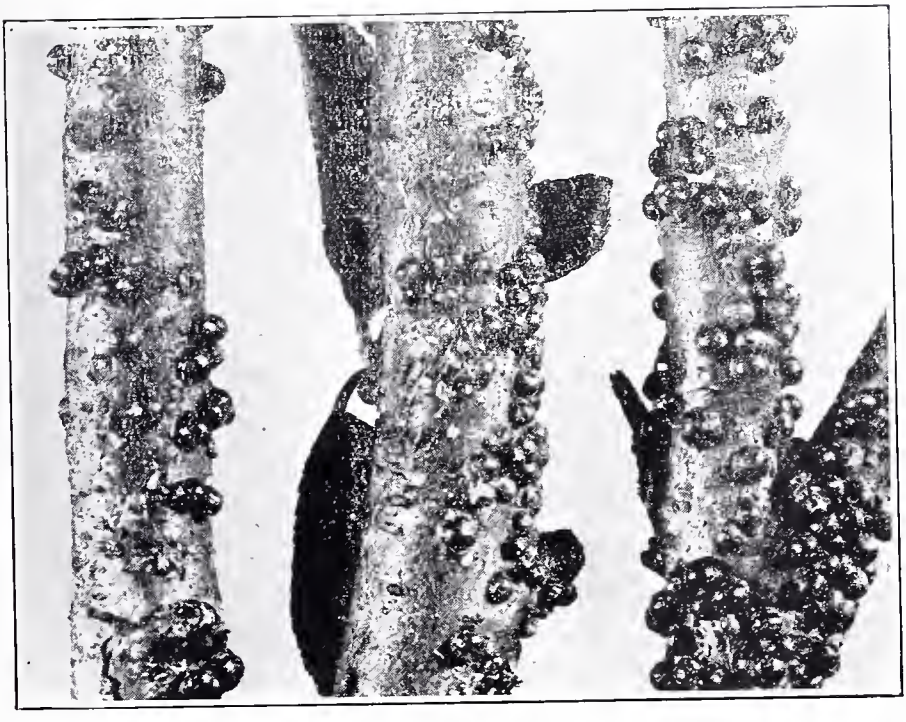
SCALE INSECTS INJURIOUS IN PENNSYLVANIA

WYOMING

By F. M. Trimble

Bureau of Plant Industry



Globular Scale, a Serious Pest of Peach and Plum Trees.

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C. H. Hadley, Director, Bureau Plant Industry.

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PENNSYLVANIA DEPARTMENT OF AGRICULTURE.

Organization and Services.

FRANK P. WILLITS, *Secretary* JOHN M. McKEE, *Deputy Secretary*

This Department is essentially a service agency created by legislative enactment to deal with administrative, regulatory, investigational, and educational problems which can best be solved through public rather than individual action. The organization provides for coordination and cooperation with the Pennsylvania State College and the U. S. Department of Agriculture. The Department operates through the following bureaus:

ANIMAL INDUSTRY: T. E. MUNCE, *Director and State Veterinarian.*

Prevents and eradicates transmissible diseases of animals and poultry, including tuberculosis of animals in cooperation with Federal Government.

Demonstrates to veterinarians control methods for transmissible animal diseases:

Supervises vaccination for and the prevention of hog cholera, anthrax, black leg and hemorrhagic septicemia;

Protects public from unwholesome meats through ante and post mortem examinations of animals at slaughtering establishments;

Inspects, licenses and furnishes information as to breeding, soundness and conformation of stallions and jacks standing for public service;

Enforces law requiring licensing of dogs and providing for protection of livestock and people from attacks of uncontrolled dogs;

Maintains laboratory for diagnostic research and experimental projects.

PLANT INDUSTRY: C. H. HADLEY, *Director.*

Tests agricultural seeds for purity and germination, and enforces State Seed Law;

Inspects orchards, parks, farms, and plant imports for injurious insects and plant diseases;

Inspects and licenses Pennsylvania nurseries, and licenses all dealers in nursery stock;

Enforces laws governing apicultural practices, disease control and housing;

Places and enforces quarantines and carries on eradication campaigns against insect pests and plant diseases;

Inspects and certifies potatoes for seed purposes;

Makes investigations for the control of injurious insects and plant diseases including field tests of insecticides, fungicides and weed killers;

Maintains collections of insects, plant diseases, plants, and seeds, and identifies specimens.

FOODS AND CHEMISTRY: JAMES FOUST, *Director.*

Accomplishes its purpose of protecting Pennsylvania homes against harmful foodstuffs by sampling, analyzing and bringing prosecution under the laws relating to foods and non-alcoholic drinks, including milk, cream, butter, ice-cream, eggs, sausage, fresh meats, soft drinks, fruit syrups, vinegar and kindred food products;

Regulates and issues licenses for the manufacture and sale of oleomargarine;

Licenses and regulates egg-opening plants and cold storage warehouses, maintaining regular inspection and enforcing twelve-month storage limit;

Inspects milk plants and creameries and regulates weighing, testing, buying and selling of milk and cream on a butterfat basis;

Protects honest manufacturers, importers, selling agents and ultimate users of feeding stuffs, fertilizers, lime products, linseed oil, paint, putty, turpentine, insecticides and fungicides, by means of annual registrations followed by inspections, analyses, prosecutions and the publication of the analyses of these products;

Analyzes special samples for residents of the State at the rate of $1.00 a sample for feeding stuffs, lime products and linseed oils.

MARKETS: P. R. TAYLOR, *Director.*

Investigates and assists in the marketing of farm products; at present chiefly grain and hay, fruit and vegetables, poultry and eggs, and tobacco;

Compiles and distributes daily market information as to supplies, shipments and prices;

Advises growers on transportation of agricultural products;

Assists cooperative associations and public markets;

Establishes standard grades of farm products and maintains inspection.

STATISTICS: L. H. WIBLE, *Director.*

Assembles and disseminates essential statistics and facts pertaining to the agriculture of the State, from monthly reports rendered by hundreds of volunteer crop correspondents, information which assists the producer in his sales and interests all industries which deal with agricultural products;

Cooperates with U. S. Bureau of Agricultural Economics in joint crop and livestock reporting and publishes annual and monthly summaries of the data;

Compiles dates of county and local fairs and assembles data pertaining to their success and results during each year.

SCALE INSECTS INJURIOUS IN PENNSYLVANIA.

F. M. Trimble

INTRODUCTION.

As a group, the scale insects are of great economic importance. Every grower or owner of woody plants has, at some time or other, experienced losses owing to the presence of some member of this family of insects. Owners of fruit orchards and nurseries especially, know that drastic treatment is often necessary to eradicate an infestation when it has not been treated in the incipient stage. Where infestations are not treated the losses may soon amount, annually, to thousands of dollars. Much of this loss may be prevented if growers will adopt the remedies as recommended in this publication, but before control measures can be intelligently undertaken it is important that a correct determination of the injurious species be made.

Of the 110 species, recorded in Pennsylvania by the Bureau of Plant Industry, which have been observed during the inspection of nursery stock, orchards and greenhouse plants, only twenty-four are considered generally injurious. In the latter group we find fifteen pests of outdoor plants and among these are several of the most serious pests of horticulture. The State Nursery Inspection Service keeps a check on the distribution of present economic species and ascertains the introduction of any new species.

The scale insects injurious to fruit trees are likewise injurious to many ornamental trees and shrubs in the nursery rows and on private grounds. Such pests as the San Jose scale, the scurfy scale and the oyster-shell scale are widely disseminated on trees in the woods and we may expect to find them any time on many of our fruit and ornamental trees when such plants are not sprayed annually. In order to assist the plant grower to determine the species of scale insect infesting his stock the following host key has been arranged.

HOST KEY.

Scale Insects Injurious to Ornamental Shade Trees.

Elms:

Oval, brown, soft scale surrounded by white cottony-like material.
European elm scale. (See Page 4).

Oblong, dirty-white, oyster-shell-shaped scale. **Elm scurfy scale.**

Brown, elongate, oyster-shell-shaped scale.
Oyster shell scale. (See Page 12).

Maples:

Large, soft, brown scale covered by wooly cottony-like mass on leaves and smal
oblong, white bodies on limbs and bark.
Wooly maple-leaf scale. (See Page 5).

With a long, felted, cottony mass at extreme end. **Cottony maple-leaf scal**

Brown oyster-shell-shaped scale.
Oyster-shell scale, (See Page 12).

Oaks:

Oval, convex, or turtle-shaped, shiny green scale in pit on bark.
Pit-making oak scale.

Pine trees:

White, elongate, oyster-shell-shaped scale on leaves.
Pine-leaf scale. (See Page 9).

Tulip trees:

Large, turtle-shaped, brown scale.
Tulip-tree soft scale. (See Page 6).

Scale Insects Injurious to Ornamental Shrubs.

Euonymus:

Light brown oyster-shell-shaped scale.
Euonymus scale. (See Page 8).

Junipers:

Oval to oblong whitish scales on leaves.
Juniper scale. (See Page 10).

Lilacs, boxwood, ash, willow:

Brown, elongate, oyster-shell-shaped scale.
Oyster-shell scale. (See Page 12).

Rose:

Flat, white, broadly oyster-shell-shaped scale.
Rose scale. (See Page 10).

Small, flat, black to brown circular scale with jet black central nipple.
San Jose scale. (See Page 11).

Scale Insects Injurious to Fruit Trees.

Apple trees:

Small, flat, black to brown circular scale with jet black central nipple.
San Jose scale. (See Page 11).

White, oyster-shell-shaped scale.
Scurfy scale. (See Page 9).

Brown, elongate, oyster-shell-shaped scale.
Oyster-shell scale. (See Page 12).

Cherry trees:
Small, flat, black to brown circular scale with jet black central nipple.
San Jose scale. (See Page 11).

Peach and plum trees:
Small, oblong, turtle-shaped scale with reddish longitudinal bands.
Terrapin scale. (See Page 7).
Small, oval, turtle-shaped brown scale.
Globular scale. (See Page 7).
Small, flat, black to brown circular scale with jet black central nipple.
San Jose scale. (See Page 11).

Scale Insects Injurious to Greenhouse Plants.

Ferns:
Oval, whitish mobile scales covered with white powdery material.
Mealy bugs. (See Page 5).
Small, circular, convex, light brown to yellowish white scale.
Greedy scale.
Oval, dark-brown, convex scale with hard shell-like covering.
Hemispherical scale. (See Page 7).

Ivy:
Small, oval, convex light brown to yellowish scale on leaves.
Ivy scale. (See Page 10).

Palms, crotons, etc.:
Oval, white to flesh colored, mobile scales covered with white powdery-like material.
Mealy bugs. (See Page 5).
Flat, oval, soft brown scales.
Soft scales. (See Page 6).
Large, flat, oblong brown scale.
Tessellated scale.
Small, circular, flat, light brown scale.
Boisduval's scale.
Larger, flat, circular, light brown to yellowish scale.
Morgan's scale. (See Page 12).
Circular dark brown scale with reddish markings.
Circular scale. (See Page 11).

Rubber plants:
Circular, dark brown scale with reddish markings.
Circular scale. (See Page 11).
Oval, dark brown, convex scale with a hard shell-like covering.
Hemispherical scale. (See Page 7).

DESCRIPTION, DISTRIBUTION, FOOD PLANTS, AND CONTROL OF IMPORTANT INJURIOUS SCALE INSECTS.

The following list of scale insects includes all of those that have been found generally injurious to commercial plants in Pennsylvania. A brief description of each species is given as a help to those people who are not thoroughly acquainted with the group.

Pit-making Oak Scale.

(Asterolecanium variolosum Ratz.)

Description.—The scales are nearly circular, from brown to shiny green or clear yellow in color, appearing semi-transparent, about one-sixteenth of an inch in diameter and usually in a pit in the bark.

Distribution.—Throughout the Eastern States and quite common in Eastern Penna.

Food plants.—Found chiefly on white and English oaks but it has been taken on red and swamp white oaks. Often kills twigs and branches on the first two host plants.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

European Elm Scale.

(Gossyparia spuria Modeer)

Description.—Fully developed females are reddish brown oval bodies surrounded by a white cottony fringe one-quarter to three-eighths of an inch long. They over-winter as partly grown adults and are usually clustered in crevices of the bark at the base of lateral twigs and leaves. In early summer, they are very conspicuous. The males are delicate, reddish, two winged insects with long white tail-like filaments. (See Plate I, fig. 1.)

Distribution.—Very common throughout the Eastern States.

Food plants.—Often injurious to American elm and has been reported on cork, Scotch, English and slippery elms in this State.

Control.—The tender young scales may be destroyed in early summer by a heavy stream of water from a garden hose. Otherwise spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

The Wooly Maple-leaf Scale.

(Phenacoccus acericola King)

Description.—The adult female is about three-sixteenths of an inch long, oval, yellow, plump and concealed by an irregular cottony mass one-quarter to five-eighths of an inch in diameter on the underside of leaves of hard maple. The adult male emerges from a white, closely woven, oval cocoon usually attached under the loose bark of the trunk and larger limbs. It has a red body with large wings covered with white powder and two long, white, tail-like filaments. (See Plate I, fig. 2).

Distribution.—Common in the Eastern States and often reported in Pennsylvania.

Food plants.—Injurious to hard maple in Pennsylvania and has also been taken on sycamore maple.

Control—Spray with miscible oil emulsion as given under insecticide number six, during the dormant season.

Mealy Bugs.

(Pseudococcus sps.)

Description.—The bodies of the adult females are light yellow to red in color according to the species, three-sixteenths to three-eighths of an inch long, body covered with a white mealy like substance and often bearing white lateral and tail-like filaments. The males are pale, delicate-winged insects with two long white tail-like filaments. (See Plate I, fig. 3).

Distribution.—Mostly greenhouse pests among which the citrus mealy bug is the most important. The outdoor species are seldom observed and not of economic importance.

Food plants.—Most all greenhouse plants are attacked, especially crotons, Coleus, ferns and palms. Out of doors they have only been recorded as injuring honeysuckle.

Control: A good syringing with water under heavy pressure will keep them down, however, tender plants cannot withstand such treatment. Fumigation at weekly intervals with one to one and a half ounces of sodium cyanide per 1000 cu. ft. of space will soon destroy them. Otherwise use a soap or nicotine oleate solution (strength depending on hardness of host plant), or spray with kerosene nicotine oleate, (1 quart to each 5 gallons of water,) as given under insecticide numbers three and four.

Cottony Maple-leaf Scale.

(Pulvinaria acericola W. and R.)

Description.—The fully developed adult female is about three-sixteenths of an inch long by one-eighth of an inch broad and about

one-sixteenths of an inch high, dark purple in color with a brown stripe, and with a long white cottony egg sac at the rear end.

Distribution.—Throughout the Northern States.

Food plants.—Injurious to soft maples in Pennsylvania and has been reported several times on red or swamp maple.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Tessellated Scale.

(Eucalymnatus tessellatus Sign.)

Description.—The adult female is flat, elongate, oval and usually broader at the rear end, dark brown, one-eighth to three-sixteenths of an inch long, one-eighth of an inch wide and surface of body divided into small plates.

Distribution.—A common pest of many plants in Pennsylvania greenhouses.

Food plants.—Often a pest of palms and bay trees.

Control.—Fumigate with sodium cyanide using one and a half ounces, as given under insecticide number one, to each 1000 cu. ft. of space weekly, until scale is all dead. The nicotine-oleate sprays, as given under insecticide numbers three and four, are also valuable in eliminating this general pest.

Soft Scales.

(Coccus species)

Description.—These scale insects are oval to elongate and slightly convex in shape with a thin light brown shell or body covering; three-sixteenths of an inch long and about one-eighth of an inch wide. (See Plate I, fig. 4)

Distribution.—Widely distributed over the world in the tropics and in greenhouses of the colder climates.

Food plants.—Infests a long list of plants, especially oleander, Camellia, ivy, bay and rubber plants.

Control.—Three to four weekly fumigations with sodium cyanide, using not less than one ounce per 1000 cu. ft. of space with an exposure of one hour. Kerosene-nicotine-oleate, one and a half fluid ounces to each gallon of water used as a dip or spray, will control this pest, if applied several times at weekly intervals.

Tulip-tree Soft Scale.

(Toumeyella liriodendri Gmel.)

Description.—One of the largest turtle-shaped scales in the Eastern States, being three-sixteenths to one-quarter of an inch in diameter, dark brown in color, nearly circular and quite convex with an ir-

regular surface. Over-winters in a partly grown stage. (See Plate I, fig. 5).

Distribution.—Common throughout Pennsylvania.

Food plants.—Infests all of the native and cultivated magnolias, but usually injures only tulip-trees.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Terrapin Scale.

(Lecanium nigrofasciatum Perg.)

Description.—The adult female is oval in shape and quite convex or raised in the center, light red to black in color with a lighter central stripe running lengthwise of the scale, one-eighth of an inch long, and about one-eighth of an inch wide. Over-winters in a partly grown stage in crevices of the bark and on the underside of limbs. (See Plate I, fig. 6).

Distribution.—Found East of the Mississippi River.

Food plants.—It is very injurious to peach trees, silver maples and hawthorns. It also infests many other plants among which plum, sycamore, and spicewood are reported in Pennsylvania.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Globular Scale.

(Lecanium prunastri Fonsc.)

Description.—A small dark reddish brown to black, turtle-shaped scale, one-eighth of an inch long and about one-eighth of an inch wide. It overwinters as a partly grown scale about one-sixteenth of an inch long in the crevices of the bark and on the underside of twigs and limbs. (See Plate 1, fig. 7).

Distribution.—First reported from Columbia, Pennsylvania in 1898 and has since spread into York County and as far north as Reading and Williamsport.

Food plants.—Seriously injures peach and plum trees and has been observed infesting apricot and sweet cherry.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Hemispherical Scale.

(Saissetia hemisphaerica Targ.)

Description.—The adult female scale is light to dark brown in color, turtle-shaped, with a shiny smooth surface and about one-eighth of an inch in diameter. (See Plate 1, fig. 8).

Distribution.—A general pest of greenhouse plants in Pennsylvania.

Food plants.—Infests a long list of house plants but has been reported in Pennsylvania as only injuring ferns, crotons and rubber plants.

Control.—Three or four weekly fumigations with sodium cyanide, using not less than one ounce per 1000 cubic feet of space with an exposure of one hour. Kerosene-nicotine-oleate, one and a half fluid ounces to each gallon of water used as a dip or spray, will control this pest, if applied several times at weekly intervals.

Elm Scurfy Scale.

(Chionaspis americana John)

Description.—The oblong body of the female scale is covered over by a white oyster-shell-shaped scale about one-eighth of an inch long. The scale is often obscured or hidden by dirt and the forward half of the scale is frequently covered by a grayish or blackish secretion.

Distribution.—Common throughout the Eastern States and found everywhere in Pennsylvania.

Food plants.—A pest of the American elm and has been reported infesting camperdown elm and red hawthorn.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Euonymus Scale.

(Chionaspis euonymi Comst.)

Description.—The adult female scale is oyster-shell-shaped, broadened toward the rear end, one-sixteenth of an inch long, and dirty brown to nearly black in color. The male scale is snow white in color, very narrow, the length being slightly shorter than the diameter of the female scale and deeply grooved lengthwise. (See Plate 1, fig. 9).

Distribution.—Found practically wherever euonymus grows.

Food plants.—All varities of euonymus may be injured by this pernicious pest. It has also been reported on woodbine *(Celastrus scandens.)*

Control.—When the young are crawling about spray several times with a soap solution, made according to the formula under insecticide number five, and containing "Black-leaf 40" at the rate of one part to 1000 of water. Otherwise spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Scurfy Scale.

(Chionaspis furfura Fitch.)

Description.—The adult female scale is broadly pear-shaped, flat, thin, about one-eighth of an inch long, and white to dirty gray in color. The male scale is nearly one-sixteenth of an inch long, elongate, narrow, with three distinct lengthwise ridges and grooves in the roughened surface. (See Plate II, fig. 1).

Distribution.—Found throughout the United States and is common everywhere in Pennsylvania in the woods and old fruit orchards.

Food plants.—Attacks a long list of plants but it is only a serious pest of pear, apple, quince, cherry, peach, currant and mountain ash. It is often found on Japan quince, wild cherry, black walnuts, crab-apple, hawthorn, ash, horsechestnut, willow, etc.

Control.—Spray with a miscible or lubricating oil emulsion, as given under insecticide number six, during the dormant season.

Pine-leaf Scale.

(Chionaspis pinifoliae Fitch.)

Description.—The adult female scale is about one-eighth of an inch long, white, narrow and elongate. The male scale is about one-sixteenth of an inch long, pure white, elongate, very narrow and slightly broadened toward the rear end. (See Plate II fig. 2).

Distribution.—Throughout the United States.

Food plants.—Infests pines, spruces, firs and Taxus species but only injures the first two named plants.

Control.—Spray with one of the commercial miscible oil emulsions, on a bright warm day during the winter months. A summer soap spray, made according to insecticide number five, while the young are crawling, will also give good results.

Boisduval's Scale.

(Diaspis boisduvalli Sign.)

Description.—The female scale is circular, about one-sixteenth of an inch in diameter, and snow-white to light yellow in color. The male scale is white, less than one-sixteenth of an inch long, and has three longitudinal ridges on the back.

Distribution.—Common throughout the States.

Food plants.—Infests a long list of greenhouse plants and is often found injuring palms, Acacia, and orchids.

Control.—Fumigate weekly with sodium cyanide using one-half of an ounce per 1000 cu. ft. of space, as given under insecticide number one. Weekly spraying or dipping with kerosene nicotine-oleate, one and a half fluid ounces diluted in each gallon of water, will also give good results.

Juniper Scale.

(Diaspis carueli Targ.)

Description.—The female scale is circular, about one-sixteenth of an inch in diameter, white to light gray in color and with a yellow raised central nipple. The male scales are very small, pure white in color, narrow and with a prominent median ridge on the back. (See Plate II, fig. 3).

Distribution.—Common in parks and gardens in the United States.

Food plants.—Often injurious to junipers and arborvitae. Also infests Biota, Cupressus and Libroccdrus species in Pennsylvania.

Control.—Spray with a commercial miscible oil emulsion on a bright sunny day during the dormant season. Good results may also be obtained by spraying with a soap solution, made according to insecticide number five, when the young are crawling in early summer.

Rose Scale.

(Aulacaspis rosae Bouche.)

Description.—The female scale is about one-eighth of an inch in diameter, nearly circular with irregular edges, white to light gray in color and with a yellowish nipple to one side. The male scale is half as long as the diameter of the female scale, white, narrow and has three ridges running lengthwise the back. (See Plate II, fig. 4).

Distribution.—Common in the United States.

Food plants.—An injurious pests of rose, blackberry, raspberry and dewberry plants.

Control.—Cut out all old canes as low as possible and spray with a miscible or lubricating oil emulsion, made according to insecticide number six, during the dormant season.

Ivy Scale.

(Aspidiotus hedcrae Vall.)

Description.—The female scale is flat, almost circular, about one-sixteenth of an inch in diameter and light gray in color with a light yellow raised central nipple. The male scale is very small, elongate and light gray in color. (See Plate II, fig. 5).

Distribution.—Common throughout the United States but only a greenhouse plant pest in Pennsylvania.

Food plants.—Among a long list of host plants we find this scale mainly injurious to ivy, ferns, Camellias and palms in Pennsylvania.

Control.—Spray with nicotine-oleate, made according to insecticide numbers three and four, at weekly intervals.

San Jose Scale.

(Aspidiotus perniciosus Comst.)

Description.—The female scale is nearly circular, slightly convex, nearly one-sixteenths of an inch in diameter, dark in color when young but gray when mature, with a black raised central or subcentral nipple surrounded by a light gray band. The male scale is dark gray to black in color, much smaller than the female and twice as long as broad. (See Plate II, fig. 6).

Distribution.—Throughout the United States.

Food plants.—This scale infests a long list of plants but is injurious mainly to peach, plum, pear, quince, white ash, mountain ash, blackberry, currant, Japan quince, and lilac.

Control.—Spray with a miscible or lubricating oil emulsion made according to insecticide number six, during the dormant season. This pest does not become serious in Pennsylvania orchards which receive an annual dormant spray of lime-sulphur, made according to insecticide number two.

Greedy Scale.

(Aspidiotus rapax Comst.)

Description.—The female scale is somewhat similar to the ivy scale, about one-sixteenth of an inch in diameter, circular, somewhat translucent, white to gray in color and with a brown to black raised central to subcentral nipple. The male scale is smaller, not so convex and otherwise similar to that of the female.

Distribution.—A thoroughly disseminated species but only a pest of greenhouse plants in Pennsylvania.

Food plants.—Infests a long list of plants, but is only injurious to a few in Pennsylvania, such as Camellia, Acacia, bay tree, citrus, etc.

Control.—Spray with nicotine-oleate, made according to insecticide number three or four, at weekly intervals.

Circular Scale.

(Chrysomphalus aonidum Linn.)

Description.—The female scale is about one-sixteenth of an inch in diameter, circular in shape, the reddish brown central nipple being covered by a gray secretion and surrounded by a reddish brown ring, and the remainder of the scale being dark brown to black except for the grayish margin of the scale. The male scale is less than one-sixteenth of an inch in diameter, elongate, and similar to the female scale in color. (See Plate II, fig. 7).

Distribution.—In greenhouses throughout the State.

Food plants.—Infests a long list of plants and has been found to be injurious to citrus, Camellia, rubber plant, oleander, Kentia, Pandanus and Aspidistra in Pennsylvania.

Control.—Fumigate with sodium cyanide using one-half an ounce to each 1000 cubic feet of space, according to insecticide number one. Weekly spraying or dipping with kerosene-nicotine-oleate, one and a half fluid ounces diluted in a gallon of water, made according to insecticide number four, will also give results.

Morgan's Scale.

(Chrysomphalus dictyospermi Morg.)

Description.—The female scale is about one-sixteenth of an inch in diameter, light brown to grayish in color, flat, thin and with a raised grayish central nipple. The male scale is similar to that of the female with the exception that it is smaller and elongate. (See Plate II, fig. 8).

Distribution.—Throughout the United States but only a greenhouse pest in the temperate zone.

Food plants.—Often injurious to orchids, Araucaria, jasmine, Kentia, Cycas, Lantana and rose.

Control.—Spray or fumigate as for the circular scale.

Oyster-shell Scale.

(Lepidosaphes ulmi Linn.)

Description.—The female scale is about one-eighth of an inch long, oyster-shell-shaped, light to dark brown in color, overwintering young are gray, and the shiny surface is marked by faint semicurcular ridges. The male scale is brown in color and much smaller. (See Plate II, fig. 9).

Distribution.—Common throughout the United States.

Food plants.—Infests a long list of plants and often injures apple, pear, elm, walnut, willow, birch, ash, poplar horsechestnut, and lilac.

Control.—Spray with a miscible or lubricating oil emulsion made according to insecticide number six, during the dormant season or spray the young crawlers in June with a soap solution, made according to insecticide number five, containing "Blackleaf 40" at the rate of one part to each 1000 parts of the soap solution.

CONTROL MEASURES.

When one or more plants show effects of insect attack, the grower should observe just how the insects feed as this fact governs the type of remedy required. All insects may be roughly divided into two classes, by the nature of their mouth parts, namely: (1) biting

and (2) sucking insects. The first group contains such forms as caterpillars which bite or chew their food. In order to control these pests an insecticide containing a stomach poison, such as lead arsenate, must be used. The other group contains those insects which suck up their food by means of a beak and is represented by the scale insects. Stomach poisons would be useless to control this latter group as the insect would insert its beak through the poison into the unpoisoned underlying tissues. Therefore contact insecticides are needed to control all of the scale insects.

Two general methods are used in combatting scale insects: first, fumigating with gas and second, spraying with caustic liquid solutions.

FUMIGATING WITH GAS.

1. *A. Sodium Cyanide Fumigation.* The fumigation of dormant nursery stock and certain greenhouse plants to control scale insects has been used extensively in Pennsylvania. The necessary equipment for successful fumigation consists of a supply of good chemicals, gallon size glass or porcelain-lined jars and an air-tight box or room that can readily be opened for ventilation. Sodium cyanide is now used in place of the less satisfactory potassium cyanide. The basic formula used is as follows:

Sodium cyanide (96 to 98 per cent)	1	oz.
Sulphuric acid (1.84 sp. gr. or 66° Baume)	1½	fl. oz.
Water	3	fl. oz.

The water is placed in the jar and the sulphuric acid is then poured in *slowly.* Stir the solution well and drop in the paper bag containing the cyanide *quietly* and *leave the room at once.* Where a large space is to be fumigated several jars should be used and two operators should be present. For dormant nursery stock three-quarters of an ounce of cyanide should be used for every 100 cubic feet of space with an exposure of not less than 50 minutes or over an hour. For greenhouse plants the dosage varies and any one contemplating fumigation by this method should obtain Bulletin 513 of the U. S. Department of Agriculture, Washington, D. C.

Sodium cyanide is one of the most deadly poisons known and should be stored in an air-tight can, plainly marked and placed out of reach of those unacquainted with its poisonous properties. The sulphuric acid should be kept in a glass stoppered bottle, also plainly marked and stored in a safe place.

Cyanide fumigation is the most efficient and cheapest means of controlling scale insects and many other greenhouse pests. However, the method has not been generally adopted due to the danger attendant to the operator, and is being displaced by contact insecticides.

B. Calcium Cyanide Fumigation. There has been developed recently a promising new cyanide having calcium as a mineral base instead of the sodium as formerly used. It is in a dry form, like so much powder, and is applied by scattering it on the earthen floor of the greenhouse or fumigation chamber. The chief killing factor lies in the long exposure, over night, and the light dosage used does not endanger the operator. These features, in addition to its cheapness and ease of application, make it a very promising insecticide which, however has not been experimented with sufficiently to warrant the Bureau of Plant Industry to recommend it for extensive use as yet.

SPRAYING WITH CONTACT INSECTICIDES.

2. *Lime Sulphur Solution.* This spray material has been the standard orchard spray for years, for the dormant season as well as during the growing season. It has the property of being a good combined insecticide and fungicide and combines well with other insecticide solutions such as arsenate of lead and nicotine. Where the orchardist consistently applies an annual dormant spray of lime sulphur the scale insect problem should not arise.

The stock lime-sulphur solution is made according to the following formula:

Stone lime	50 pounds.
Sulphur (commercial ground)	100 "
Water (to make finished product)	50 gallons.

The materials are measured out and all lumps in the lime and sulphur are broken up. Place the lime in the cooking vessel and add enough water to prevent burning during slaking. If in a hurry hot or boiling water will expedite the slaking. When the lime slaking is well under way or just complete, add the sulphur which has previously been worked into a thin paste by use of water. Then add enough water to make the full amount as called for in the formula and enough in addition to allow for evaporation during the cooking. Boil this solution until all of the sulphur granules have dissolved, which experience has shown us to be close to fifty minutes of vigorous boiling. This solution should be thoroughly stirred during boiling and time kept in order to prevent under or over-boiling. Care should also be taken that the volume does not drop below that given for the finished product, and the operator should be protected from the caustic fumes and hot solution by goggles and rubber gloves. When boiling is finished, withdraw the solution from the fire. If to be used at once, cool off a little

in a separate vessel and test with a hydrometer. The only safe way to make dilutions of lime-sulphur solutions is by the use of a lime-sulphur hydrometer. The instrument should be graduated in both the specific gravity and Baume scales. It is more convenient to make a test of a container full of the concentrate and then determine the rate of dilution for material taken therefrom than to test each tankful of spray material. In order to save time one should have a two or three gallon measure with which to do the measuring for large quantities such as for dormant spray. The following table gives the proper dilution to be made for stock solutions of certain strengths:

Hydrometer reading of concentrated Lime-Sulfur		Gallons of water to one gal. of Lime-Sulfur	Gallons of Lime-Sulfur Concentrate for 100 gal. of spray
Degrees Baume	Specific Gravity	For San Jose Sale	For San Jose Sale
30	1.261	7¼	12½
29	1.250	6⅞	13⅛
28	1.239	6½	13¾
27	1.229	6	14½
26	1.218	5⅝	14¾
25	1.208	5¾	16
24	1.198	5	16¾
23	1.188	4½	18¼
22	1.179	4¼	19
21	1.169	3⅞	21
20	1.160	3½	22½
19	1.151	3¼	23½
18	1.142	3	25
17	1.133	2⅞	26½
16	1.124	2½	28½
15	1.115	2¼	30¾

Where orchardists have not used the proper strengths or have omitted the dormant spray, the scale insects will soon become abundant and do a large amount of injury. Such infestations soon become heavy enough to form a crust or layer of scales on the tree and one dormant spray of lime-sulphur will not kill enough of them to remove the danger. When such conditions arise, the orchardist should use one of the miscible or lubricating oil emulsions, which have the power to penetrate through the encrustation.

3. *Nicotine Oleate.* This recently developed spray material has proved to be valuable in killing the young forms of scale insects on the more tender greenhouse plants. The formula is as follows:

Nicotine (40% nicotine sulphate in the free form)	2½ parts
Oleic acid (Red oil)	1¾ parts
Water (Rain or soft.)	4¼ parts

When the oleic acid is added to the nicotine a soft soap-like mixture forms. To this add the water. For scale insects on tender plants as Coleus and Begonia dilute one fluid ounce of the stock solution with two gallons of water. Hardier plants will withstand one fluid ounce in each gallon of water. A good syringing of the plants with water the following morning will prevent any possible burning.

4. *Kerosene Nicotine Oleate.* A spray for scale insects on the greenhouse plants is made from the following formula:

Solution 1.	Kerosene	8 ounces
	Oleic acid	1 "
Solution 2.	Nicotine (40% nicotine sulphate)	2 "
	Water	8 "

Pour the oleic acid into the kerosene slowly, stirring constantly, In another vessel mix the nicotine and water thoroughly. The final stock solution is obtained by mixing these two combinations together forming a mixture with a creamy consistency. Rapidly churning or pumping the mixture back upon itself will produce the best results. For use in killing scale on palms and like hardy plants, dilute one fluid ounce in one gallon of water. All plants should be syringed well with water the morning following the application of this spray.

5. *Soap Solution.* Fish-oil soap or common laundry soap will control scale insects if applied when the young crawlers are about. The formula is:

Fish-oil soap or laundry soap	1 lb.
Water	2 to 4 gals.

The chipped soap is dissolved in boiling water and the solution should be used while still warm, but not hot. Care should be taken not to permit the solution to collect at the base of plants and all sprayed plants should be syringed with water the following day to prevent any possible injury to the tender growth.

6. *Miscible or Lubricating Oil Emulsion.* The long established dormant strength spray of lime-sulphur for control of heavy infestations of scale insects is now being displaced to a large degree by commercial and home-made miscible or soluble oil sprays. The home-made and commercial lime-sulphur solutions are still being used and are invaluable for certain purposes. However, where the problem is one in which scale control is urgent the Bureau of Plant industry recommends the use of one of the miscible, or lubricating oil emulsions.

With the recurrence of heavy infestations of San Jose scale orchardists are finding that sprays of miscible oil emulsion give better results. These should be applied on a bright sunny day during the dormant season when the temperature is above 40° Fahrenheit. The oil sprays spread rapidly and penetrate into cracks and crevices where lime-sulphur cannot reach those scale insects protected by the old bark. The commercial miscible oil sprays on the market have been standardized and can be depended upon when diluted according to instructions given on the container.

The common lubricating oils, such as Diamond Paraffin, Red Engine, Nabob and 188 Red Neutral, which have a paraffin base, have given good results as emulsion sprays for scale insects on dormant trees. The following formula is used:

Engine oil	1 gal.
Water	½ gal.
Potash fish-oil soap	1 lb.

The oil, water and soap are placed in a kettle or other receptacle and heated until the contents come to a boil. A brown scum appears on the surface of the mixture as it first begins to boil. After boiling for a few minutes the brown scum begins to disappear: just at this stage remove the kettle from the fire and pump the mixture back into itself twice under 60 pounds pressure while still very hot. A pump must be used to make the emulsion, as stirring will not produce a good mixture, and for this purpose a small bucket pump is quite satisfactory. The stock emulsion contains 66 2/3 per cent oil. To make a two per cent spray use six gallons of this stock in a 200 gallon spray tank. Water used in diluting the stock must be soft. If only hard water is available, soften by adding one pound of lye to each 100 gallons before the stock solution is added.

A more recent development of the lubricating oil emulsion which has given excellent results for the Bureau of Plant Industry is made as follows:

Engine Oil	2 gallons
Water	1 gallon
Kayso	4 ounces

The Kayso is placed in solution in the water by slowly sifting into the water while the water is being stirred. The oil is then placed into the container and the mixture pumped back into itself for about three minutes. No heat is needed in making this emulsion and hard water may be used in making the dilution. To make a 2% solution dilute six gallons of the stock solution in a 200 gallon spray tank of water.

This spray solution has come into use all over eastern United States and promises, as soon as the oils used have become standardized, to displace all of the other miscible and lubricating oil emulsions used for scale insect control.

PLATE I

1. European elm scale,—natural size.
2. Wooly maple-leaf scale,—reduced one half natural size.
3. One of the mealy bugs,—enlarged four times.
4. One of the soft scales,—slightly enlarged.
5. Tulip-tree soft scale,—slightly enlarged.
6. Terrapin scale,—enlarged one and a half times.
7. Globular scale,—slightly enlarged.
8. Hemispherical scale,—natural size.
9. Euonymus scale,—slightly reduced.

Photographs: 1 by Dr. W. E. Britton; 3 and 4 by J. G. Sanders; others by H. B. Kirk.

PLATE I

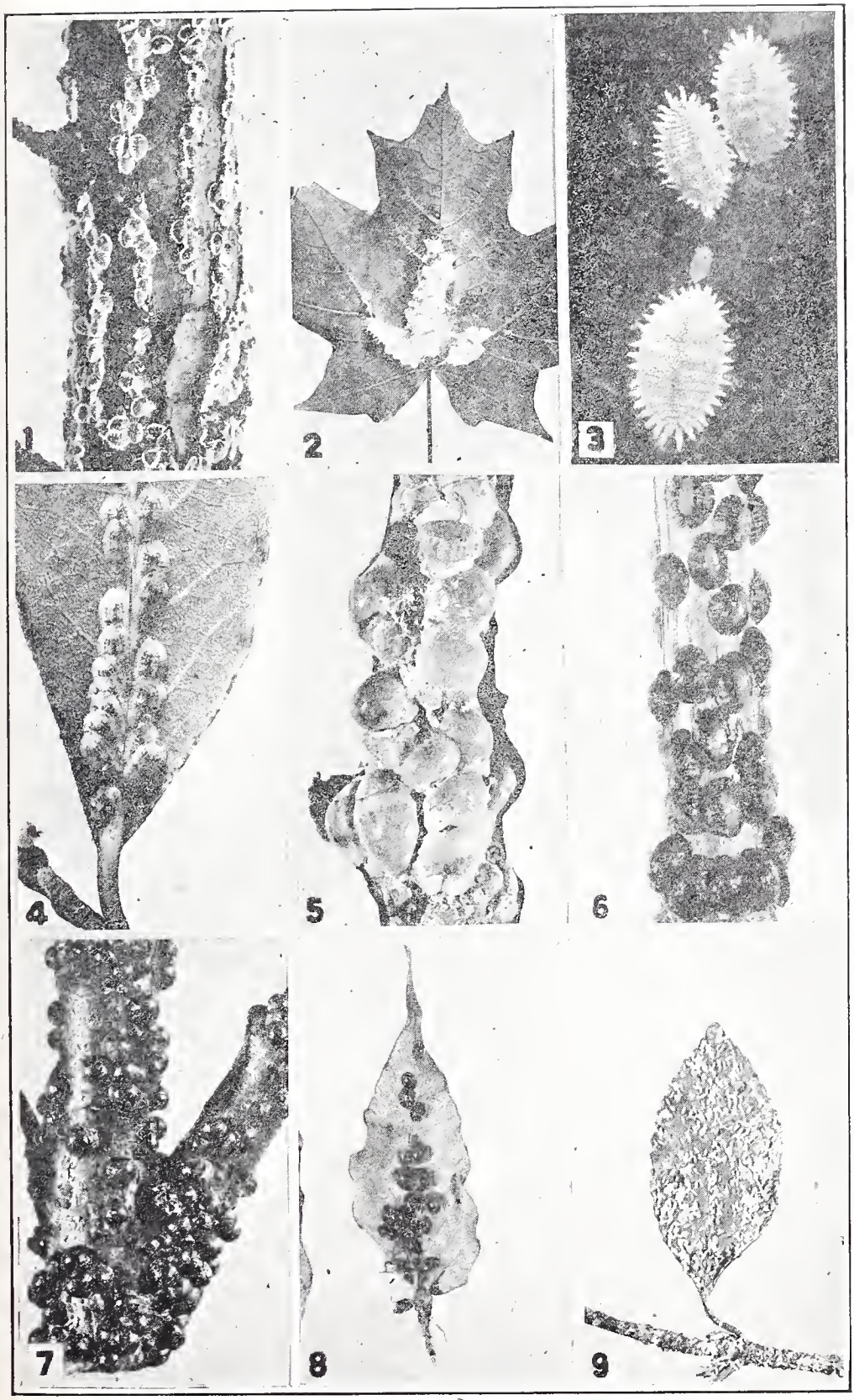

PLATE II

1. Scurfy scale,—reduced one half.
2. Pine-leaf scale,—reduced one half.
3. Juniper scale,—slightly enlarged.
4. Rose scale,—enlarged one time.
5. Ivy scale,—enlarged one time.
6. San Jose scale,—enlarged four times.
7. Circular scale,—slightly enlarged.
8. Morgan's scale,—enlarged three times.
9. Oyster-shell scale,—enlarged two times.

Photographs: by H. B. Kirk.
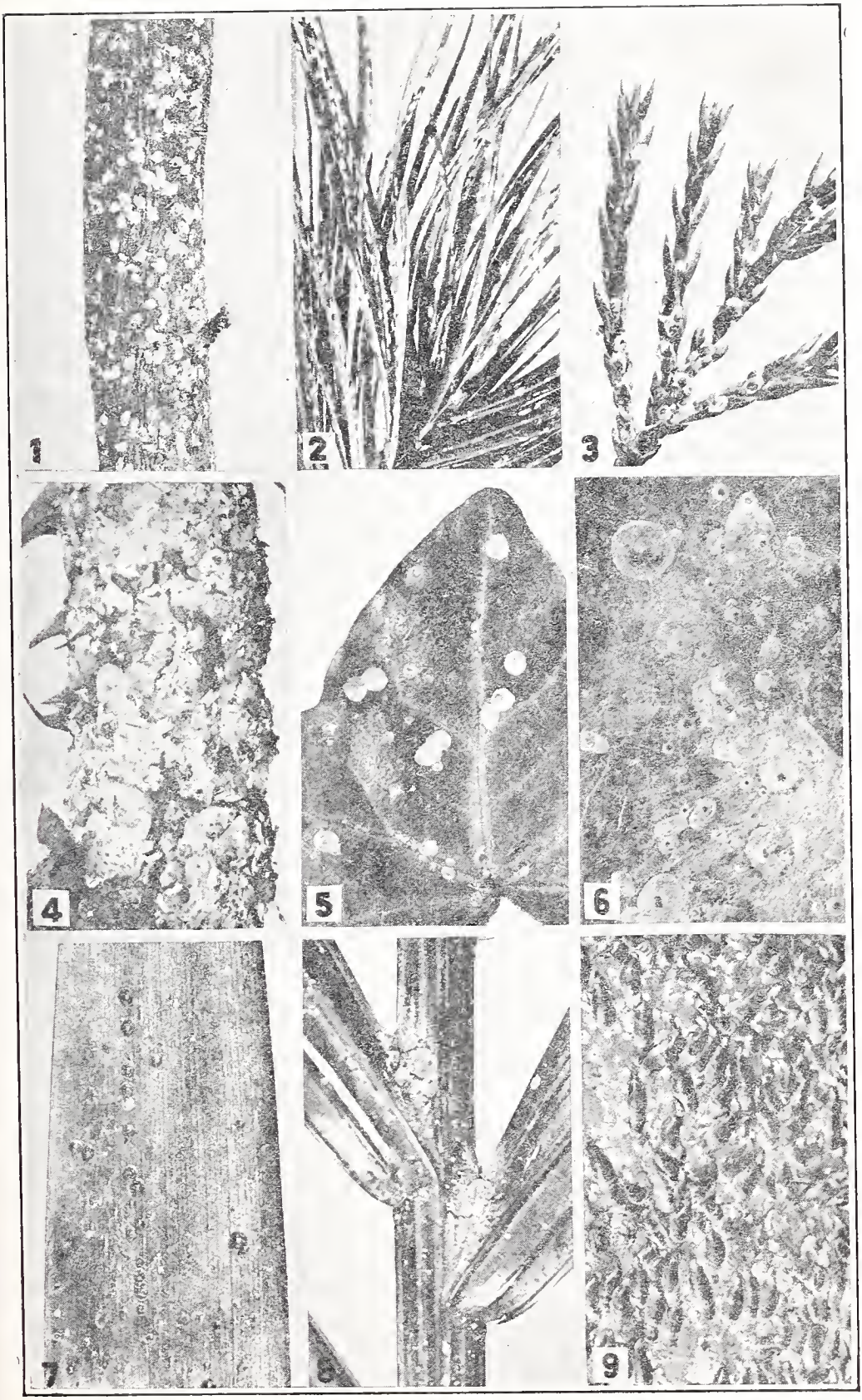
PLATE II